(19) Europäisches Patentamt
European Patent Office
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(11) EP 0 794 558 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
10.09.1997 Bulletin 1997/37

(51) Int. Cl.[6]: **H01L 21/00**, H01L 23/04, G01L 9/00, H01L 23/10

(21) Application number: **96308160.9**

(22) Date of filing: **12.11.1996**

(84) Designated Contracting States:
DE FR GB

(30) Priority: **26.02.1996 US 606929**

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(54) **Hermetic seal for an electronic component having a secondary chamber**

(57) A hermetic seal for an electronic component has a cap 10 with laterally extending walls 14. The laterally extending walls define a main chamber therebetween. A cavity 20 is formed in the end of the laterally extending walls to define a secondary chamber and divide the end of the laterally extending walls into a first area and second area. The cap 10 is hermetically sealed to a base 22 at the first and second areas of the laterally extending walls so that the secondary chamber and the main chamber are separately hermetically sealed.

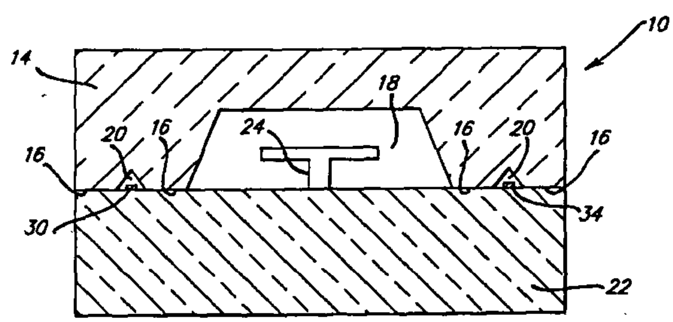

FIG. 3.

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Description

The present invention relates generally to a hermetic seal for an electronic component, and more specifically to a sealing apparatus having a secondary chamber.

Hermetically sealed electronic devices are well known. The simplest form of such a device involves a ceramic package, with a cavity which receives the electronic device, and a metallic lid. The lid is soldered in place such that a hermetic seal is effected. More recently, various approaches to prepare a smaller, more local, hermetic microchamber have been attempted, particularly for Micro Electro Mechanical Systems (MEMS) applications. Typically, a silicon micromachined structure, commonly referred to as a cap, is bonded over the device by thermal compression or anodic bonding techniques.

One problem with this approach is that stresses resulting from cap bonding may degrade the performance or operational characteristics of the device. The temperature dependence of this stress may be quite significant for many MEMS applications such as sensors and actuators. Furthermore, temperature cycling of such a structure in the presence of stress may result in the eventual failure of the hermetic seal. Once a leak occurs, the functional characteristics of the device or its calibration may be altered.

It is, therefore, desirable to improve the quality of the hermetic bond by directly reducing the stress. Further, a technique to sense or monitor any changes in the integrity of the hermetic seal would be highly desirable.

According to the present invention, there is provided an encapsulating structure for a component as hereinafter set forth in Claim 1 of the appended claims.

The preferred embodiment of the invention overcomes the disadvantages of the related art by providing a cap having a base portion with laterally extending walls. The laterally extending walls define a main chamber therebetween. A cavity is formed in the end of the laterally extending walls to define one or more secondary chamber and divide the end of the laterally extending walls into a first area and second area. The cap is hermetically sealed to the base at the first and second areas of the laterally extending walls to the base. Both the first area and second area are hermetically sealed to seal the secondary chamber from the main chamber and the environment in which the device is used.

An advantage of the preferred embodiment of the present invention is that since the outer wall of the cap is made thinner by the addition of a secondary chamber the wall structure is more flexible and therefore can conform to local non-uniformities in the silicon structure.

Another further advantage is that stress is reduced over conventional hermetic caps since the area over which to dissipate stress is increased.

A still further advantage is that the secondary chamber may contain a variety of passive or active devices to monitor the integrity of the chamber.

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a micromachined cap according to the present invention,
Figure 2 is a top view of a substrate according to the present invention,
Figure 3 is a cross sectional view of a cap bonded to a substrate,
Figure 4 is an alternative embodiment of a cap according to the present invention, and
Figure 5 is a cross sectional view of an alternative embodiment of the present invention.

Referring to Figure 1, a cap 10 is shown that is used to encapsulate an electronic structure. Cap 10 has a base portion 12 with laterally extending walls 14. Four laterally extending walls are shown as an example. Any number of walls, however, may be used. Each of walls 14 have an end 16, the ends of the walls 14 being preferably coplanar. A main chamber 18 defined by walls 14 is used for enclosing an electronic component. A cavity 20 is formed into end 16 of laterally extending walls 14. Each of ends 16 preferably has a cavity 20 forming a continuously connected secondary chamber in each of ends 16. Cavity 20 is preferably sized to reduce the surface area of end 16. A cavity having a volume about that of main chamber 18 was found to give desirable results.

Cap 10 is preferably micromachined from a single piece of silicon, glass or ceramic material. The cap as shown is 3 millimetres by 1 millimetre.

Referring now to Figure 2, a base 22 is used for housing an electronic structure 24, such as a tilt plate capacitor, as shown, or an integrated circuit. Base 22 is substrate such Pyrex. Pyrex has a different coefficient of thermal expansion from the silicon cap 14. The area 26 corresponding to cavity 20 is shown in phantom lines. Electronic structure 24 has contact pads 28 that are used to connect electronic structure 24 external to cap 10. A gettering alloy 30 may be aligned with the cavity 20 to deliberately induce a pressure differential in the secondary chamber. Gettering alloy 30 has contact pads 32 for activation of gettering alloy 30.

A leak detector 34 may also be incorporated into the secondary chamber. A leak detector 34 may be a pressure sensor, corrosion test structure, a humidity sensor or other methods of sensing a leak in the hermetic seal. Contact pads 36 connect leak detector 34 external to the cap 10.

The secondary chamber may also have a signal conditioning circuit to process the signal. Many signal processing circuitry may include processing such as filtering.

Referring now to Figure 3, a cross sectional view of cap hermetically sealed to base 22 is shown. Typically the hermetic seal is provided anodically or formed by thermal compression bond. Because cap 10 and base 22 are made of different material having different coeffi-

cients of thermal expansion, stresses build up in ends 16. Due to the addition of cavity 20 laterally extending walls 14 become more flexible to allow stress to be dissipated. Also because of the flexibility in external laterally extending walls 14 non-planarity of base 22 can be compensated.

Referring now to Figures 4 and 5, the corresponding structure from that of figure 1 is shown. Cap 10' having ends 16' are shown with two cavities 20' . Each or either of cavities 20' may have a leak detection means or a gettering alloy for detection of leaks and inducing pressure differentials in the cavity. By adding an extra cavity 20' laterally extending walls 14' become more flexible which reduces stress and further increases conforming to non-planarity of base 22'. Such a structure also increases the reliability of the encapsulation since both chambers must be violated before the main chamber 18' is violated.

Claims

1. An encapsulating structure for a component comprising:

   a cap (10) having a base portion (12) with a laterally extending wall (14), said wall having a thickness and an end (16), said wall defining a main chamber (18) for housing the component (24) therein;
   a cavity (20) formed in the end (16) of said laterally extending walls (14) defining a secondary chamber thereby dividing said end (16) into a first area and a second area; and
   a base (22);
   said first area and said second area each forming a hermetic seal and with said base (22).

2. An encapsulating structure as claimed in claim 1, further comprising detection means (34) disposed within said cavity (18) for detecting a failure of one of said seals.

3. An encapsulating structure as claimed in claim 2, wherein said detection means (34) comprises a pressure sensor.

4. An encapsulating structure as claimed in claim 2, wherein said detection means comprises a humidity sensor.

5. An encapsulating structure as claimed in claim 2, wherein said detection means (34) comprises a corrosion test structure.

6. An encapsulating structure as claimed in claim 2, wherein said detection means (34) comprises a gettering alloy.

7. An encapsulating structure as claimed in any preceding claim, wherein said cap comprises silicon.

8. An encapsulating structure as claimed in any preceding claim, wherein said cavity (20) extends continuously in said end (16) of said cap (10).

10. An encapsulating structure as claimed in any preceding claim, wherein a plurality of substantially parallel cavities (20') are formed in the end (16') of said laterally extending walls (14') defining secondary chambers dividing said end (16') into a plurality of areas that form hermetic seals with said base.

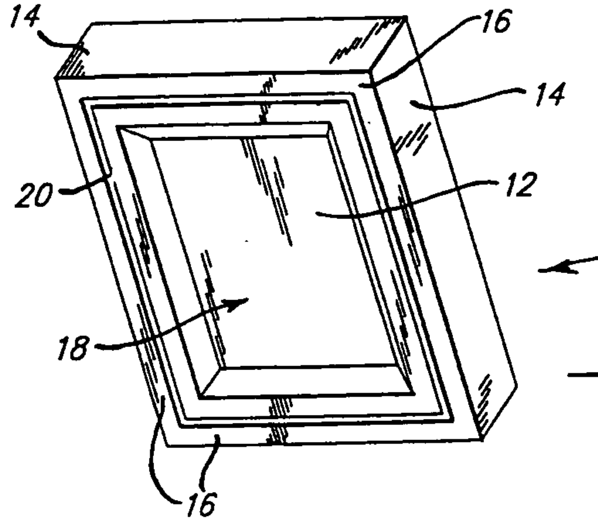

FIG. 1.

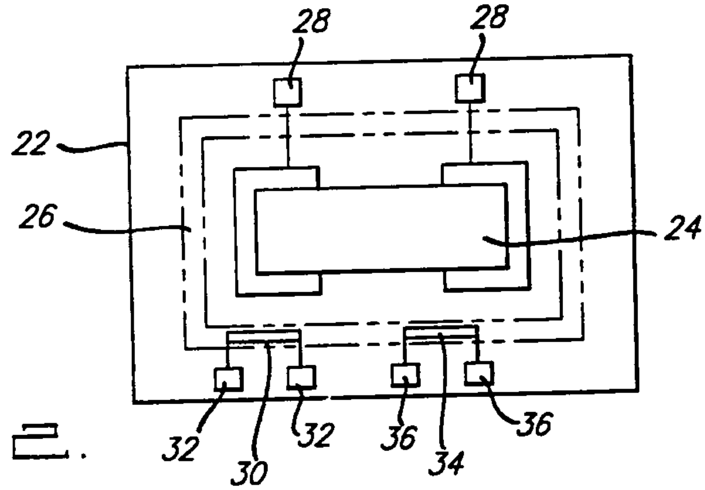

FIG. 2.

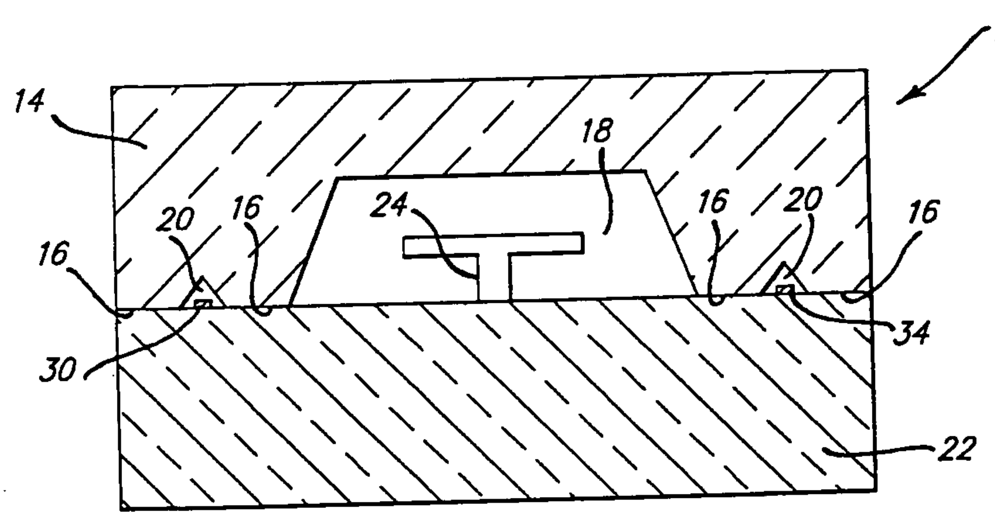

FIG. 3.

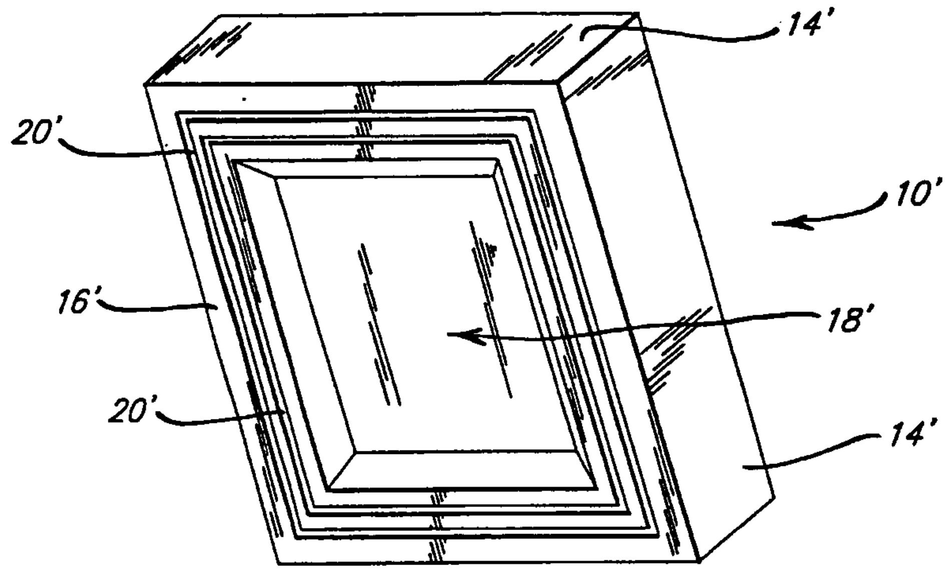

FIG. 4.

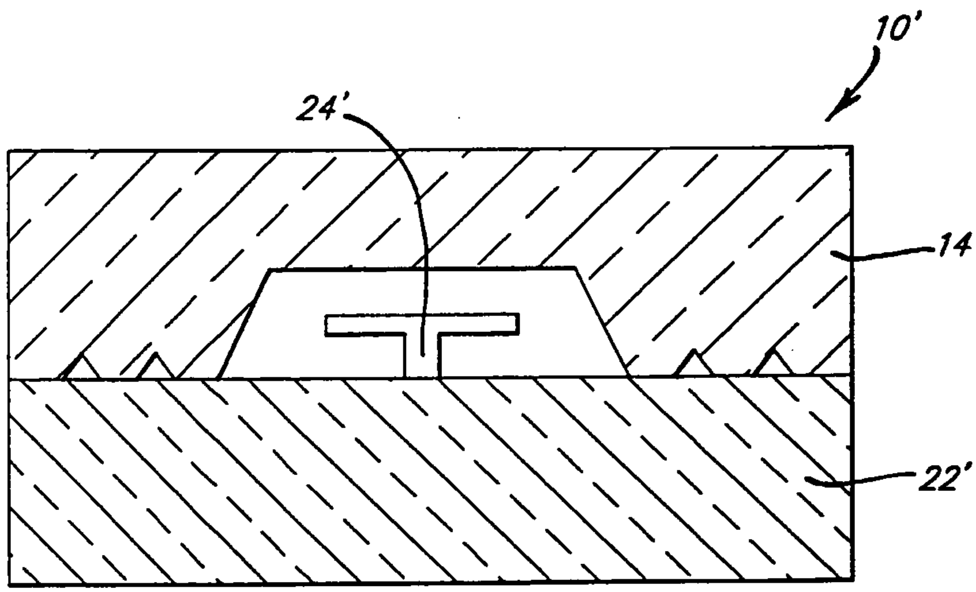

FIG. 5.

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EUROPEAN SEARCH REPORT

Application Number
EP 96 30 8160

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 5 448 444 A (PROVENZANO PAUL L ET AL) 5 September 1995	1,7,8	H01L21/00 H01L23/04 G01L9/00 H01L23/10
Y	* the whole document *	2-6	
X	US 5 317 922 A (BOMBACK JOHN L ET AL) 7 June 1994 * the whole document *	1,7,8,10	
Y	US 3 943 557 A (FRAZEE LAWRENCE E ET AL) 9 March 1976 * the whole document *	2,4,5	
Y	US 4 553 020 A (VAL CHRISTIAN) 12 November 1985	6	
A	* the whole document *	1,2,4,5	
Y	FR 2 575 289 A (BOSCH GMBH ROBERT) 27 June 1986	3	
A	* the whole document *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 009, no. 140 (E-321), 14 June 1985 & JP 60 021544 A (HITACHI OUME DENSHI KK;OTHERS: 01), 2 February 1985, * abstract *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6) H01L G01L
A	US 4 400 870 A (ISLAM SAFIDUL) 30 August 1983 * the whole document *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	4 July 1997	Brock, T

CATEGORY OF CITED DOCUMENTS

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